Original Report

Meningococcal Meningitis among Rwandan Refugees: Diagnosis, Management, and Outcome in a Field Hospital

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ABSTRACT

Objective: To study the diagnostic process, clinical course, and outcome of Rwandan refugees with meningococcal meningitis, treated in an Israeli field hospital in Goma, Zaire, in the summer of 1994.

Methods: Patient hospital charts and laboratory records were reviewed with critical evaluation of clinical presentation and diagnostic tests. Patients were treated as part of a disaster relief effort in a refugee camp experiencing several coexisting lethal epidemics.

Results: A total of 65 patients were identified as having group A meningococcal meningitis. Latex agglutination test for *Neisseria meningitidis* soluble antigen in the cerebrospinal fluid was found to be a superior diagnostic tool, as compared to Gram stain, and at least as effective as culture. The mortality rate was 14%; mortality was markedly affected by co-morbidity (e.g., dysentery, pneumonia, and malnutrition).

Conclusions: The outcome of patients with meningococcal meningitis, treated in referral centers within a disaster area may be favorable, despite overwhelming coexisting epidemics, and may be comparable to that achieved in advanced medical facilities. Encephalopathy may be a diagnostic pitfall in the perspective of coexisting epidemics, requiring a high index of suspicion and routine lumbar puncture. The latex agglutination test is highly useful in achieving prompt diagnosis of meningococcal meningitis, in particular when sample handling for culture and microscopy is suboptimal.

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Epidemic meningococcal disease has been a feature of sub-Saharan Africa for over a century. Major epidemics of group A *Neisseria meningitidis*, caused in particular by clone III-1, spread over the last decades from China to the sub-Saharan "meningitis belt."[1-5] They were controlled only after nonselective immunization of the population in affected areas with polyvalent vaccine against *N. meningitidis* group A and C.[6,7]

Tribal war in Rwanda during June and July 1994 resulted in a major medical disaster, with over 100,000 refugees dying within a few weeks at the Rwanda-Zaire border, north of Lake Kivu. Manslaughter, cholera, and bacillary dysentery were the initial and leading lethal epidemics, followed chronologically by malnutrition, meningitis, and malaria.[8,9]

Over 65 patients with meningococcal meningitis were relocated for treatment to the Israeli Army Field Hospital in Goma, Zaire. This communication summarizes their medical course and proposes guidelines for the diagnosis and management of such patients in disaster areas.

MATERIAL AND METHODS

During July and August 1994, 3600 patients were treated by the Israeli Relief Mission. The hospital served as the first echelon for patients (most of whom presented with a cholera-like illness) from nearby refugee camps during the first 2 weeks, then was converted, over the next 4 weeks, into a referral medical facility, backing up primary-care facilities and cholera camps, under the coordination of the United Nations High Commissioner for Refugees (UNHCR).[10] During this period an outbreak of meningococcal meningitis occurred almost simultaneously in several refugee camps, but was most striking in Kibumba. A substantial fraction of these patients were referred to the Israeli field hospital,[8] or were transported by a mobile

team of the hospital from primary care facilities within the camps.

In the triage tent of the hospital a lumbar puncture was done routinely on all suspected cases, and a Gram stain was performed at the hospital's laboratory. In most cases, duplicate samples of cerebrospinal fluid (CSF) were sent to the microbiology laboratory of the French Army Medical Corps (Bioforce) who were encamped at the Goma airport. Lumbar puncture was not repeated in referred partially treated patients, as their diagnosis was established at the first medical echelon by the clinical presentation and a turbid CSF. Some CSF samples from the latter patients also reached the French laboratory.

An isolation tent for meningitis was constructed; it was divided into pediatric and adult sections. It was run by a nurse and one or two corpsmen/paramedics during day shifts, and one corpsman/paramedic at night. Patients were attended by an internist or pediatrician, guided by a specialist in infectious diseases. Patients remained in this unit until convalescence and discharge from the hospital, with occasional exceptions who required further treatment or rehabilitation and who were moved to other wards for the rest of their hospital course.

At the Bioforce laboratory, CSF samples were analyzed by Gram stain and by latex agglutination test for the presence of *N. meningitidis* soluble antigens (Pastorex A/B/C, SANOFI Diagnostics Pasteur, France). Cerebrospinal fluid samples were cultured using standard procedures. Subgroup classification of *N. meningitidis* cultures was determined using a latex agglutination test (SANOFI Diagnostics Pasteur).

The authors retrospectively analyzed the clinical course and outcome of patients with meningococcal meningitis, using the patients' hospital files and records of the French Army microbiology laboratory. Although the Israeli field hospital was run by three successive teams, each operating for 2 weeks, the medical archive of only the first two teams was available for analysis. The medical records of the last team were lost during transport. Of 2525 patients treated by the first two teams (between July 26 and August 22, 1994) 2146 medical records (85%) were available for analysis. The diagnosis of meningococcal meningitis in this type A epidemic was based on: (A) positive CSF Gram stain for gram-negative diplococci, or positive culture or positive latex agglutination test for soluble antigen (definitive diagnosis); or (B) a clinical picture compatible with bacterial meningitis, associated with the presence of turbid CSF; or (C) a clinical picture compatible with meningitis and documented incomplete treatment for suspected meningococcal meningitis at the first medical echelon.[8] Sixty-five patients fulfilling these inclusion criteria were identified (43, 13, and 9 patients belonging to categories A, B, and C, respectively) and most of their demographic data, clinical course, and laboratory findings were retrieved. The medical records of 16 convalescing patients, admitted during the final week of the second medical team were among the records lost during transportation, but their laboratory data were accessible.

Data were evaluated with a statistics program (Crunch Software Corporation, USA). Values are presented as means ± SEM. Descriptive statistics, simple correlation, multiple regression analysis, Student's t-test, and Pearson chi-square analysis were applied as detailed below, with statistical significance set at $P < 0.05$. Since some variables were often missing, the numbers of patients with available data for each variable detailed below appear in parentheses.

RESULTS

Demographic Features

Demographic and clinical data of the 65 patients with meningococcal meningitis are summarized in Table 1. Their mean age (13.4 ± 1.4 years) was younger than that of the unselected hospitalized population (18.4 ± 0.4 years, n = 1986, $P < 0.05$). Half of the patients were 10 years old or less, the youngest being 1 week old. Patient admissions data, stratified chronologically according to the day of admission and the source refugee camp, are presented in Figure 1. Two distinct clusters of cases were noted: the first, consisting of patients from Muginga refugee camp, lasted from day 7 through day 20 and peaked at day 14. The second, comprised of patients arriving simultaneously from Kibumba camp and from the district of Goma, started on day 15, peaked on day 21, and declined afterward, perhaps as the result of a vaccination project in Kibumba.[9]

On the average, admission occurred within 1.5 days after the beginning of symptoms. Delay in admission occurred in 10 of 32 patients, and was often related to earlier diagnosis and treatment in the first echelon. Two of these patients were treated with long-acting chloramphenicol intramuscular injections at the referring medical facility.[7,11,12] One patient was treated with penicillin and three others received other antibiotics. Four patients were misdiagnosed before admission and treated for malaria, with quinine.

Clinical Data

Fever was present in all patients (n = 30), signs of meningeal irritation in 94% of 36 patients (27 with nuchal rigidity and 7 with opisthotonos), and altered consciousness in 51% of 35 patients (7 with somnolence, 8 with stupor, and 3 in deep coma). Six of 36 (17%) presented with generalized convulsions on admission or during hospitalization, and one patient arrived in profound shock. Two patients presented with concomitant extrameningeal infection (one with monoarthritis of the knee, and another with purulent keratoconjunctivitis). None of

Table 1. Demographic Data and Clinical Features in 65 Patients with Meningococcal Meningitis

Variable	*Values*†		*Remarks*
Age (yr) (n = 53*)	13.3 ± 1.4		Mean age of unselected hospitalized patients was 18.4 ± 0.4; n = 1986
Sex (males/females) (n = 52*)	25/27		
Refugee camp (n = 53*)	Kibumba	30	
	Muginga	12	
	Goma district	11	
Prehospitalization period (d) (n = 23*)	1.5 ± 0.2		
Hospitalization period (d) (n = 46*)	4.5 ± 0.3		
Co-morbidity (n = 36*)	Dysentery	6	
	Cholera	3	
	Pneumonia	2	
	Malnutrition	1	
	Malaria	1	
Clinical features (n = 30–36*)	Fever	30/30	
	Nuchal rigidity	34/36	7 with opisthotonos
	Encephalopathy	18/35	7 with somnolence; 8 with stupor, and 3 in deep coma
	Convulsions	6/36	
	Shock	1/36	
Diagnosis (n = 42–56*)	Abnormal CSF	52/56	45 turbid, 7 bloody
	Gram stain	31/43	
	Culture	38/42	
	Latex	41/42	
Treatment (n = 37*)	C + P	29	2 died
	C	6	1 died
	P	1	died
	Ciprofloxacin	1‡	died
Outcome (n = 45*)	Full recovery	37	82%
	Neurologic deficit	2	4%
	Death	6	13%

*Number of documented observations; †mean ± SEM; ‡ciprofloxacin given alone due to early misdiagnosis (see text); C = chloramphenicol; P = penicillin.

the patients presented with the clinical syndrome of meningococcemia.

Three patients with non-meningococcal bacterial meningitis were excluded from this series: two succumbed to gram-negative meningitis (*Escherichia coli* and *Enterobacter* sp.), complicating advanced bacillary dysentery with septicemia, and an additional patient presented with meningitis and a huge cervical abscess. Turbid CSF in this case was not further evaluated to identify the causative organism, and the patient recovered on empirical therapy of chloramphenicol, penicillin, gentamicin, and cefazolin.

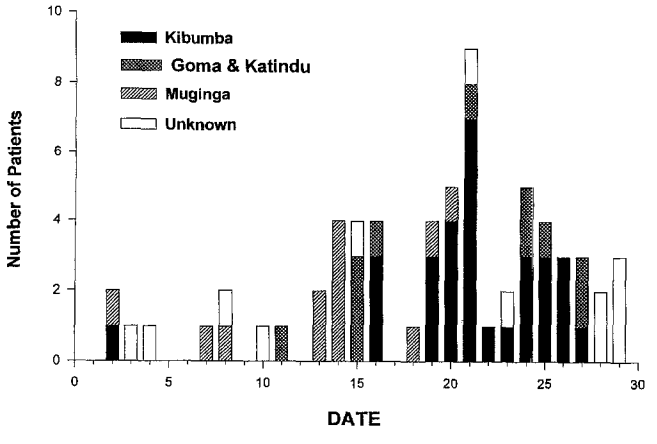

Figure 1. Chronologic distribution of 65 patients with meningococcal meningitis, also stratified according to the refugee camps from which they came. Date refers to the day of patients' admission. The airborne field hospital landed at Goma, Zaire, on July 25, 1994, (day 0) and the first patients were admitted within 24 hours of arrival.

Information on coexisting diseases was available in 11 of 36 patients (31%): three had cholera-like illness and six had bacillary dysentery. Pneumonia, malaria due to *Plasmodium falciparum,* and advanced malnutrition were diagnosed in each of three patients. As previously reported,[13] 17 patients with meningococcal meningitis were tested for human immunodeficiency virus (HIV) infection. Two (12%) were found to be HIV-1 seropositive, as compared to 33 of 110 unselected patients without meningitis (30%).

Diagnostic Yield

Cerebrospinal fluid samples from 42 patients were processed at the Bioforce reference laboratories; CSF specimens from an additional 14 patients were processed only at the field hospital's laboratory. Altogether, CSF was reported to be turbid in 45 of 56 samples (80%), bloody in 7 of 56 (13%), and clear in 4 of 56 (7%). Gram stain showed gram-negative diplococci in 31 of 43 patients (72%). Latex agglutination tests for soluble antigens were positive in 41 of 42 CSF samples (98%), all were serotype

Table 2. Cerebrospinal Fluid Analysis*

Number of Specimens (n = 42) (100%)	*Turbid or Bloody CSF (n = 38) (90%)*	*Gram Stain (n = 30) (71%)*	*Culture (n = 38) (90%)*	*Latex Agglutination (n = 41) (98%)*
28	+	+	+	+
7	+	−	+	+
1	+	+	−	+
1	+	−	+	−
1	+	−	−	+
1	−	+	+	+
1	−	−	+	+
2	−	−	−	+

*Diagnostic yield of CSF appearance, Gram stain (gram-negative diplococci), culture (*Neisseria meningitidis*), and latex agglutination test for soluble antigen of *Neisseria meningitidis* group A in 42 CSF samples of patients diagnosed as having meningococcal meningitis and evaluated at the Bioforce reference laboratory. Additional 24 processed CSF samples from the Israeli hospital did not meet any of the inclusion diagnostic criteria: 22 were negative by all parameters and 2 turbid samples grew gram-negative bacilli, that were also identified by direct Gram stain and were negative by the latex agglutination test (true negative).

A. *Neisseria meningitidis* serogroup A was recovered in cultures from 38 of the 42 samples (90%).

Table 2 summarizes the various combinations of findings at the Bioforce laboratories. Cerebrospinal fluid of the two other patients who had gram-negative bacilli visualized on microscopy yielded *E. coli* and *Enterobacter* sp. on culture. Latex agglutination for meningococcal soluble antigens was negative in both patients. Twenty-two additional microscopically negative CSF samples (not included in this series) also failed to yield a positive agglutination test for meningococcal soluble antigen or a positive culture for meningococci.

Medical Course and Outcome

Complete follow-up was available for 45 patients: 37 (82%) apparently recovered fully, 2 had obvious residual neurologic damage (4%), and 6 died (13%). The hospital course was short, averaging 4.5 days, and was not affected by the exclusion of patients who died. A combination of parenteral antibiotic therapy with penicillin (4.0 million U 6 times a day; pediatric dose: 150,000–250,000 U/kg/day) and chloramphenicol (1.0 g 4 times a day; pediatric dose: 100 mg/kg/day) was used as the initial therapy in 78% of patients (29/37). Of those receiving this combination, the mortality rate was low (7%), whereas of the seven others treated with chloramphenicol alone (n = 6) or penicillin alone (n = 1), two died (29%, one receiving chloramphenicol and the other penicillin alone). One additional patient with meningococcal meningitis was admitted with what appeared to be clinical dysentery, altered mentation, and profound shock. He was initially treated with parenteral ciprofloxacin, and died within hours after arrival, shortly after lumbar puncture was performed.

Mortality correlated with the presence of co-morbidities, including dysentery, pneumonia, or severe malnutrition ($r = 0.54$, $P < 0.001$) and with the presence of encephalitic features ($r = 0.53$, $P < 0.02$). It correlated inversely with combination antibiotic therapy ($r = 0.6$, $P < 0.006$), but the different outcome between patients on one versus two antibiotics failed to reach statistical significance (Pearson chi-square analysis, $P = 0.16$). Mortality rates were comparable among the three inclusion categories and were not affected by prehospitalization course, sex, age, the presence of generalized convulsions, or various CSF findings. Regression analysis determined that co-morbidities significantly affected the outcome (B-0.51, Beta 0.34, F-to-remove 4.7, $P = 0.037$) with the impact of treatment modality on mortality falling short of statistical significance (B-0.37, Beta 0.28, F-to-remove 3.7, $P = 0.064$).

DISCUSSION

This report presents an analysis of the clinical presentation and hospital courses of 65 patients with meningococcal meningitis; it is compromised by its retrospective nature and by incomplete documentation. Nevertheless, it provides a unique view of medical care of a highly contagious and lethal infection in a disaster area where medical facilities were limited and directed mainly at providing mass treatments. Though these conditions may not be optimal for individual patient care, this study shows that it may be possible, even in a disaster relief setting, to achieve rates of success in treating meningococcal meningitis that are comparable to those in advanced medical facilities and at referral centers attending meningococcal epidemics.[3,14–20] In fact, the overall mortality in this series may have been as low as 10%, had we considered as cured the 16 convalescing patients, for whom no final outcome information was available.

Most patients (94%) with meningococcal meningitis presented with meningeal signs, while 48% had altered state of consciousness on admission. These figures may be somewhat misleading since many patients without typical meningeal signs may have succumbed undiagnosed at the first medical echelon inside the camps. Impaired consciousness, which could have resulted from other prevalent causes, such as shigella encephalopathy, cerebral malaria, nutritional deficiencies, and electrolyte abnormalities, was a source of diagnostic pitfalls, especially if unaccompanied by meningeal signs. Thus, four patients with meningococcal meningitis were erroneously treated in the first medical echelon for cerebral malaria, and a fifth one, presenting at the triage unit only with encephalopathy and bloody diarrhea was given ciprofloxacin for presumed shigella dysentery.

All patients included in this series underwent lumbar puncture, either at the first echelon or at the authors'

facility. The importance of this simple bedside procedure cannot be overemphasized, even in an epidemic setting in a disaster area. This procedure seemed especially important in patients with altered mentation in the absence of meningeal signs, as observed in 6% of meningitis cases as well as in 2% of 1068 refugees who presented with clinical dysentery (Unpublished data). Additionally, experience suggests that turbid CSF may not suffice for the appropriate antibiotic management of patients during an epidemic of meningococcal meningitis, especially in settings of parallel epidemics. A more definitive diagnostic procedure seemed warranted. This is well illustrated by the two patients with culture-proven gram-negative bacillary meningitis complicating dysentery (3% of all patients with bacterial meningitis), or by the patient with meningitis and a huge cervical abscess, treated with four antibiotics for an undiagnosed pathogen.

In this study it was possible to compare the diagnostic yield of a CSF Gram stain, culture, and the latex agglutination kit for the detection of soluble meningococcal antigen. This evaluation was limited, however, since a gold standard has not been defined to establish the diagnosis: patients were considered as having a definite meningococcal meningitis (category A), if *any* of the three diagnostic tests was positive. Thus, the specificity and the predictive values of these tests could not be assessed (for instance, one could argue that the single case of positive latex agglutination test and negative Gram stain and culture is a false positive). With this limitation in mind, however, if all positive findings are considered as true positives, the latex agglutination test seems to be superior for the diagnosis of meningococcal meningitis (98% sensitivity), as compared to Gram stain (71%) or culture (90%). The test was negative in all 22 normal CSF samples and in the two patients with Gram negative meningitis (100% specificity). This is comparable with previous observations,[19,21] and underscores an advantage of the agglutination technique under the circumstances, where sample handling was not optimal: CSF was often processed long after it was obtained, after being kept in a refrigerator for up to 24 hours before delivery to Bioforce laboratories. Such a delay could have resulted in a reduced efficacy of culture and microscopic evaluation. Since culture requires more time and equipment, it seems that under disaster conditions the CSF appearance, Gram stain, and latex agglutination will suffice for diagnosis of most cases of meningococcal meningitis. The latex agglutination test may even substitute for microscopy during a meningococcal epidemic,[7] with Gram stain and CSF culture reserved for selected patients (e.g., typical clinical features or turbid CSF and negative latex agglutination).

The impact of other co-morbidities, such as dysentery, pneumonia, or malnutrition upon patients' outcome was remarkable. To the authors' knowledge, these prognostic factors have not been described before in outbreaks of meningococcal meningitis. The lower incidence of HIV infection among patients with meningococcal meningitis is probably the result of their younger age, as compared to the unselected population treated in the authors' facilities.

The efficacy of the combined chloramphenicol-penicillin regimen for meningococcal meningitis was high (7% mortality), comparable to that achieved in most advanced medical facilities. The use of chloramphenicol (n = 6) or penicillin (n = 1) alone was associated with a higher mortality rate of 29%, but the numbers were too small for statistical significance. Though penicillin is currently considered the drug of choice,[22] intramuscular injection of chloramphenicol has been suggested as the first-line treatment for meningococcal infection in epidemics in disaster settings.[11,12,23] Other groups have reported what appeared to be a relatively poor efficacy of this monotherapy. Some of these patients died, awaiting transportation.

Interestingly, all 20 evaluable patients from Kibumba camp survived, as compared to 19 of 25 patients from other camps (76%). This may reflect a selection bias, since Kibumba was the refugee camp most remote from Goma, and some patients referred to the authors' facility from that camp were given initial treatment at the primary care facility, whereas others died before treatment and transportation were available. This is in contrast to patients arriving directly from refugee camps closer to the field hospital, without a delay for diagnosis or pretreatment at a primary care facility.

The favorable outcome of the authors' patients occurred despite the fact that corpsmen provided most of the nursing care. Under meticulous supervision and instruction by the head nurse, they quickly mastered the numerous preparations and frequent intravenous administrations required for the combined penicillin and chloramphenicol regimen. Under these circumstances, single daily intramuscular injections of ceftriaxone would have been more convenient. Incorporation of physicians, experienced in disaster medicine and in infectious diseases, within the framework of the military mission provided the ability to "specialize" in complex medical conditions, such as bacterial meningitis. Referral medical facilities have a role in these types in disaster areas, to supplement and back up primary care medical systems that lack the capacity to address such medical problems.

In conclusion, in the midst of epidemics of meningococcal meningitis, cholera, and dysentery, the recovery rate from meningitis among Rwandan refugees was comparable to that achieved in advanced medical facilities. Cure rates were influenced by co-morbidities, such as shigellosis, pneumonia, and malnutrition. Encephalopathy without meningeal signs was a diagnostic pitfall, in the perspective of coexisting epidemics. This required a high index of suspicion and routine lumbar puncture in such patients. The latex agglutination test for soluble antigen in the CSF was highly useful in achieving prompt diagnosis

of meningococcal meningitis, in particular when sample handling for culture and microscopy was suboptimal. The combined regimen of chloramphenicol and penicillin was effective, achieving a high cure rate. Finally, relief teams operating referral centers within the disaster area may back up primary care facilities, by specializing in complex medical conditions, such as meningococcal meningitis.

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